USAEHA

U.S. Army Environmental Hygiene Agency

PRELIMINARY ASSESSMENT SCREENING NO. 38-26-K19X-93
ST. LOUIS ARMY AMMUNITION PLANT
ST. LOUIS, MISSOURI
11-14 JANUARY 1993

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11-93

DEPARTMENT OF THE ARMY
HEADQUARTERS, US ARMY AVIATION AND TROOP COMMAND
4300 GOODFELLOW BOULEVARD, ST. LOUIS, MO 63120-1798

REPLY TO
ATTENTION OF

JUN 02 1993

SATAI-A (200-1a)

MEMORANDUM FOR Commander, U.S. Army Environmental Hygiene Agency (AEHA), ATTN: HSHB-ME-SG, Mr. Barrett Borry, Aberdeen Proving Ground, Maryland, 21010-5422

SUBJECT: Preliminary Assessment Screening (PAS) No. 38-26-K19X-93, St. Louis Army Ammunition Plant (SLAAP), St. Louis Missouri

1. Reference:

a. PAS No. 38-26-K19K-93, 11-14 January 1993, AEHA.

b. Memorandum, SATAI-A, 15 April 1993, subject as above.

2. Per our phone conversation on 1 June 1993, the comments per reference 1b. are acceptable and will become part of the final PAS.

3. Comments per reference 1b. will be included as part of the PAS whenever a copy is distributed.

4. If there are any questions please contact Mr. Jim Kuehnle, DSN 693-2273.

LARRY E. WRIGHT
Director, Administrative and
Installation Support Activity

AMCEN-A (SATAI-A/26 Apr 93) (200-1a) 1st End Cunanan DSN 284-0324
SUBJECT: Request for Army Environmental Hygiene Agency (AEHA) to Perform a Site Investigation of the Basement Area, Building NO. 3, St. Louis Army Ammunition Plant (SLAAP)

11 MAY 1993

CDR, USAMC, 5001 Eisenhower Ave., Alexandria, VA 22333-0001

FOR Commander, U.S. Army Environmental Hygiene Agency, ATTN: HSHB-ME-SH (Mr. J. Resta), Aberdeen Proving Ground, MD 21010-5422

1. This office endorses the request of the basic memorandum for AEHA Field Services (Program 37- Hazardous Waste Study, see enclosed AEHA Form 250). This request has been coordinated with Mr. Resta. Direct coordination with the installation is permitted.

2. The point of contact for this action is Mr. Pete Cunanan, AMCEN-A, DSN 284-0324.

3. AMC -- America's Arsenal for the Brave.

ANDRES TALTS, P.E.
Chief, Environmental Quality Division
Office of the Deputy Chief of Staff for Engineering, Housing, Environment, and Installation Logistics

Encl
nc

CF:
CDR, ATCOM, ATTN: SATAI-A

DEPARTMENT OF THE ARMY
HEADQUARTERS, US ARMY AVIATION AND TROOP COMMAND
4300 GOODFELLOW BOULEVARD, ST. LOUIS, MO 63120-1798

REPLY TO
ATTENTION OF

APR 26 1993

SATAI-A (200-1a)

MEMORANDUM FOR Commander, U.S. Army Materiel Command, ATTN: AMCEN-A, Mr. Stan Lowe, 5001 Eisenhower Avenue, Alexandria, Virginia 22333-0001

SUBJECT: Request for the Army Environmental Hygiene Agency (AEHA) to Perform a Site Investigation of the Basement Area, Building No. 3., St. Louis Army Ammunition Plant (SLAAP)

1. Reference Preliminary Assessment Screening (PAS), January 11-14, 1993 by AEHA. [redacted] recommendation of the PAS was to conduct further investigations of the basement area of Building No. 3 SLAAP.

2. A request for field services to the AEHA for the basement investigation is enclosed for your action. It is our understanding from conversations with AEHA that they have the capability to conduct the investigation. As stated on the work request, the target completion date for the investigation is the forth quarter of FY93.

3. The point of contact for this action is Mr. Jim Kuehnle, DSN 693-2273.

LARRY E. WRIGHT
Director, Administrative and Installation
Support Activity

Encl.
CF: HSHB-ME-SH (Mr. John Resta)

1. DESCRIPTION OF THE SERVICE REQUESTED
Program No. 37 Hazardous and Medical Waste

Description Basement Investigation, Building No. 3 St. Louis Army Ammunition Plant (SLAAP).

A Preliminary Assessment Screening (PAS), Jan 93, recommended investigation of the basement of Building No. 3. The investigation will require soil sampling and analysis The known potential contaminantes are PCB's, asbestos, fuel oils. The building baseme spread footings on soil. There are a few concrete walkways. Clearance is about 5-7 fe Electric lighting is minimal. The basement area is aproximately 136,800 square feet (180x760). The structure was built in the 1940's. Building plans are available. Respiratory protection while spending long periods in basement is recommended.

2. GENERAL INFORMATION

a. Organization US Army Aviation and Troop Command ATCOM, SATAI-A
b. Installation St. Louis Army Ammunition Plant SLAAP
c. MACOM US Army Materiel Command AMC
d. (SubMACOM)
e. Supporting MEDDAC
f. Name of POC Mr. Jim Kuehnle, SATAI-A
h. Phone Number of POC Comm 314-263-2273 DSN 693-2273
i. AEHA POC Mr. John Resta, HSHB-ME-SH DSN 584-3651

j. Signature _____ Date _____
k. Letter/FONECON _____ Date _____

3. MACOM PRIORITIZATION

a. ____ Immediate b. ✓ High c. ____ Medium d. X Low e. ____ Und
f. 4093 Preferred Quarter
g. MACOM Control Number E93108 (Optional)
h. Title/Name of MACOM POC Mr. Stan Lowe / Mr. Rob Cunanan
i. Phone Number of POC DSN 284-9386 / 250-0226

j. Signature [signature] Date 4 Mar 9

4. AEHA ADMINISTRATION

	AEHA USE ONLY		
a. Entry Number			
b. Project Number			
c. Category			
d. Quarter Scheduled			
e. Field Work Scheduled			
f. Prelim Report Available			
g. Final Report Available			
h. Date Cancelled			
i. Field Work Rescheduled			
	Y	M	D

j. Reason for Delay/Cancellation

DEPARTMENT OF THE ARMY
HEADQUARTERS, US ARMY AVIATION AND TROOP COMMAND
4300 GOODFELLOW BOULEVARD, ST. LOUIS, MO 63120-1798

REPLY TO
ATTENTION OF

APR 15 1993

SATAI-A (200-1a)

MEMORANDUM FOR Commander, U.S. Army Environmental Hygiene Agency, ATTN: HSHB-ME-SG, Mr. Barrett Borry, Aberdeen Proving Ground, Maryland, 21010-5422

SUBJECT: Review of Preliminary Assessment Screening No. 38-26-K19X-93, St. Louis Army Ammunition Plant (SLAAP), St. Louis Missouri

1. The subject document has been reviewed. The following comments are provided.

a. Cover. The word "Desoto" should be deleted. The office symbol is SATAI-A.

b. Executive Summary 2.b.(2). The statement that " Bldg. 3 cleanup does not fully comply with the Notice of Violation (NOV)" implies that ATCOM is not proactively remediating the site. This is not the case. Based on the original interpretation of the NOV, the original contract called for cleanup to 8.5 feet. The Environmental Protection Agency (EPA) in its 9 April letter called for the entire building to be cleaned. Some areas above 8.5 feet have already been cleaned. Presently the contractor is preparing a cost proposal for other additional building cleanup above 8.5 feet. ATCOM fully intends to comply with all laws and regulations. The above comment applies for Page 7, Section 5.c(4)(d), Page 8 (6), and Page 18, Section 7.b.

c. Page 1 Section 2.b(6). As mentioned on page 8, parts of the basement of building 3 may be contaminated, not the entire basement.

d. Page 4 Section 5.b(3). Presently the site is not occupied by government people other than contracting personnel working on the building cleanup.

e. Page 7 Section 5.c(4)(b). The NOV specified clean up levels for building No. 3. It was the EPA letter of 9 April 92 that further clarified the entire building should be cleaned before occupancy.

f. Page 8 Section 5.c(5)(b). Former transformer pads were at various locations in the basement along the north and south building walls.

g. Page 9 Section 5.c(7)(d). ATCOM would be the action office to conduct a cost analysis.

h. Page 10 Section 5.c(8)(b). The window sills of building 4 and building 2 consist of sheet lead.

2. The above comments should be considered for inclusion into the PAS. The report is much appreciated and once finalized, action will begin on the recommendations made. The final PAS is also needed to proceed with pending excessing actions. If there are any questions please contact Mr. Jim Kuehnle, DSN 693-2273.

LARRY E. WRIGHT
Director, Administrative and
Installation Support Activity

DEPARTMENT OF THE ARMY
U.S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010-5422

REPLY TO ATTENTION OF

EXECUTIVE SUMMARY
PRELIMINARY ASSESSMENT SCREENING NO. 38-26-K19X-93
ST. LOUIS ARMY AMMUNITION PLANT
ST. LOUIS, MISSOURI
11-14 JANUARY 1993

1. PURPOSE. This assessment screening was conducted to determine whether hazardous substances were stored, released, or disposed of at the St. Louis Army Ammunition Plant (SLAAP), and to identify potential health and environmental liabilities.

2. CONCLUSIONS.

a. The conclusions reached in this report are based on a comprehensive records review, personnel interviews, and property inspection. Site conditions have been characterized to the extent achievable by these means.

b. [redacted] hazardous substances have been confirmed within some of the structures at SLAAP. Releases of other hazardous substances are also suspected. The key areas of known or suspected hazardous substance release are presented below:

(1) Major amounts of polychlorinated biphenyls (PCBs) have been released into the internal structure of Bldg 3.

(2) The U.S. Environmental Protection Agency (EPA) has issued a Notice of Violation (NOV) requiring cleanup of the internal surfaces of Bldg 3. The ongoing Bldg 3 cleanup does not fully comply with that NOV.

(3) Deteriorating asbestos pipeline insulation exists in Bldg 4A, Bldg 7, and the basements of Bldgs 3, 5, and 6.

(4) Lead based paint is suspected to have been used on both the exteriors and interiors of the buildings.

(5) The water supply lines may contain enough lead to cause lead to exceed the National Primary Drinking Water Regulations action level in the drinking water.

(6) Based primarily on consideration of heavy PCB usage in Bldg 3, the underlying earthen basement is also potentially contaminated with PCBs.

(7) The basement area of Bldg 5 slightly exceeded recommended radon levels.

3. RECOMMENDATIONS.

a. Reassess the proposal of unrestricted future use for Bldg 3. Because Bldg 3 occupies a large and central portion of the installation property, the disposition of Bldg 3 could impact the proposed excess of the entire SLAAP parcel.

b. Conduct a cost analysis of Bldg 3 decontamination, Bldg 3 destruction and proper disposal, or Bldg 3 restricted access.

[redacted]

d. Coordinate with the EPA the installation's reassessment of Bldg 3 disposition. The USAEHA is available to assist the installation in assessing the disposition of Bldg 3, in any coordination meetings or negotiations with the EPA, and in certifying decontaminated areas as clean.

e. Notify the receiving party of all hazardous substance releases known to have occurred. Take the following actions if the SLAAP property is to be excessed for unrestricted use.

(1) Implement the appropriate repairs and corrective actions for all identified areas of deteriorating and friable asbestos.

(2) Sample water distribution points to determine the presence of lead.

(3) Notify any prospective recipient of the potential for the property to contain lead based paint.

(4) Continue to maintain increased radon monitoring in the basement of Bldg 5 to determine if further mitigation measures are necessary.

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DEPARTMENT OF THE ARMY
U.S. ARMY ENVIRONMENTAL HYGIENE AGENCY
ABERDEEN PROVING GROUND, MARYLAND 21010-5422

HSHB-ME REPLY TO ATTENTION OF

PRELIMINARY ASSESSMENT SCREENING NO. 38-26-K19X-93
ST. LOUIS ARMY AMMUNITION PLANT
ST. LOUIS, MISSOURI
11-14 JANUARY 1993

1. REFERENCES. See Appendix A for a list of references.

2. AUTHORITY.

a. Memorandum, ATCOM, SATAI-A, 26 October 1992, subject: Request for Preliminary Assessment Screening for the St. Louis Army Ammunition Plant.

b. AEHA Form 250-R, AMC, 26 October 1992.

c. Memorandum, USAEHA, HSHB-ZA, 29 December 92, subject: USAEHA Schedule of Field Services, FY 93.

3. PURPOSE. This assessment screening was conducted to determine whether hazardous substances were stored, released, or disposed of at St. Louis Army Ammunition Plant (SLAAP), and to identify potential health and environmental liabilities.

4. GENERAL.

a. Personnel Contacted. See Appendix B for a list of personnel contacted.

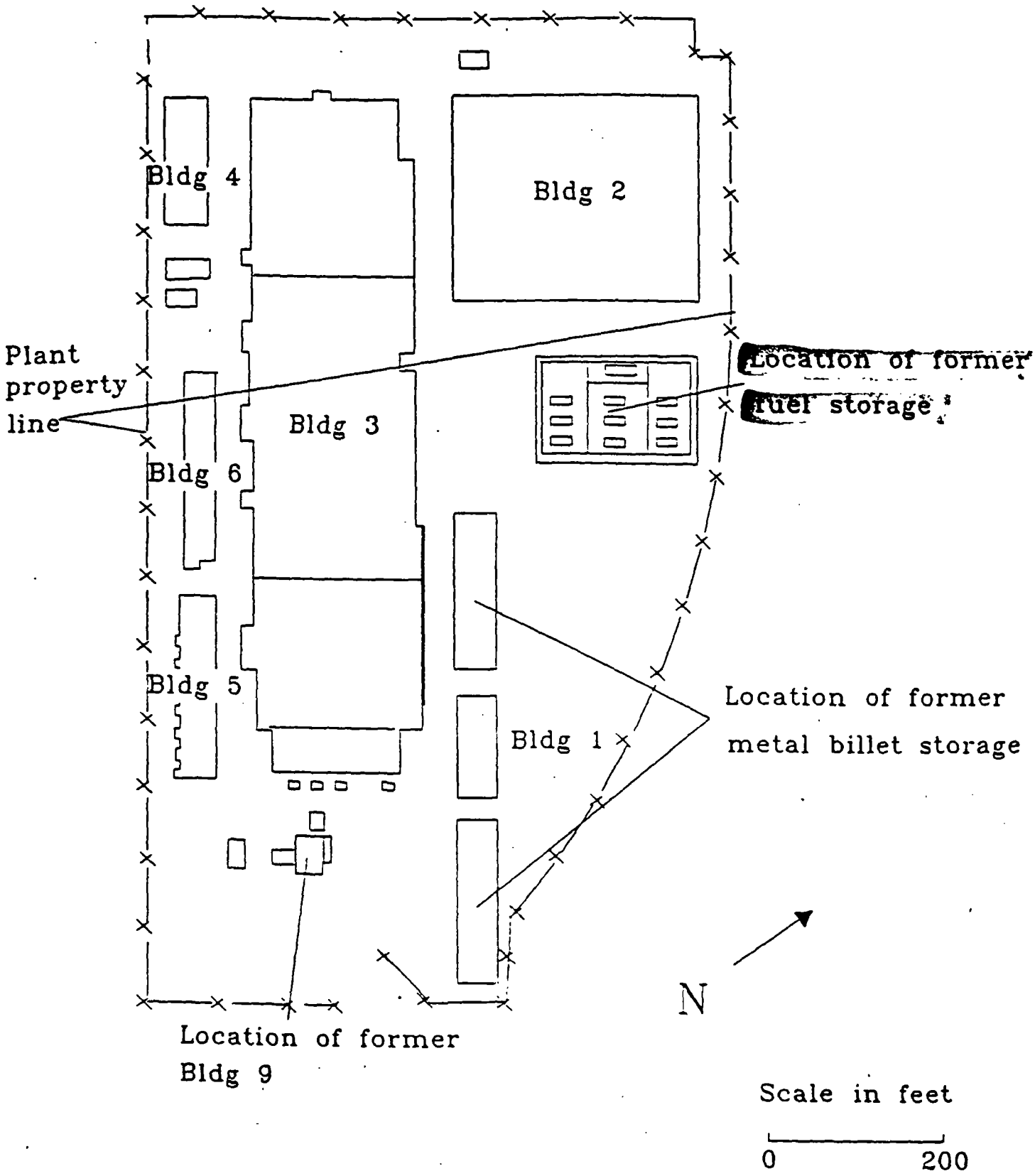
b. Background.

(1) The SLAAP is located in the northern portion of the city of St. Louis, Missouri, southeast of the interchange between Interstate 70 and Goodfellow Boulevard. The Mississippi River is located about 3 miles to the east. The property consists of 21 acres, and contains six major buildings and several smaller structures. The SLAAP area is defined by and enclosed by a cyclone fence. See the Figure.

(2) The SLAAP is being proposed for excess by the Aviation and Troop Command (ATCOM). At the time of this report, no party had been identified to receive the excessed property. This PAS is based on the assumption that the property will have unrestricted future use.

c. Environmental Setting. The following very briefly describes the environmental setting of the SLAAP area. This information is important in understanding the contamination potential at the SLAAP site.

FIGURE. ST. LOUIS ARMY AMMUNITION PLANT, ST. LOUIS, MISSOURI.



(1) Physiography/Topography. The SLAAP area is located in the southern portion of the Dissected Till Plains Section of the Central Lowland Province. The topography of this area consists of rolling uplands with slopes between 2 to 5 percent at elevations up to 550 feet above mean sea level (MSL). The SLAAP is nearly flat with an elevation of about 120 feet MSL. The SLAAP is bounded on the north by Interstate 70, on the west by Goodfellow Boulevard, and on the east by Riverview Boulevard. The SLAAP area gently slopes to the south.

(2) Geology.

(a) Surficial deposits in the SLAAP area consist of windblown silts and clays known as loess. The loess was derived from the Missouri River floodplain during the Pleistocene Age (2 million years ago). Loess deposits are reported to be about 25 feet deep on the SLAAP property (reference 1). Soils borings drilled to investigate underground storage tanks generally verified silty clays and clays to depths of 20 feet (reference 2). All but about 3 acres of the ground surface area at SLAAP is covered with asphalt or buildings.

(b) Bedrock in the area consists of flat lying sedimentary formations, mostly limestone and dolomite. A soil test boring drilled in 1971 at SLAAP encountered limestone at a depth of 65 feet (reference 1). The limestone was identified as "apparently" the St. Genevieve limestone of the Mississippi Age (320-360 million years). Approximately 43 feet of clay shales were encountered overlying the limestone. A generalized stratigraphic column for the area is presented in Appendix C.

(3) Hydrogeology.

(a) All bedrock units in and around St. Louis are capable of yielding varying amounts of water to wells (reference 1). Well yields are dependent upon site specific geologic and well characteristics. Most wells in the St. Louis area reportedly yield a maximum of 50 gallons/minute. Water yields of up to 1900 gallons/minute were reported in the thick alluvial material (reference 1).

(b) The SLAAP purchases its water from the St. Louis water system. No potable water wells are reported to exist within 3 miles downgradient of the installation (reference 3). Ground-water flow direction in the area is reported to be to the north-northeast, toward the Mississippi River (reference 3).

(4) Climate. The climate of the St. Louis area has been defined as "humid continental" and is characterized by four distinct seasons. Summers are warm and extended periods of extremely hot temperatures are rare; temperatures of ≥90 °F occur 35 to 40 days a year, usually during July and August. Spring and autumn are generally moderate. Winters are brisk without extended periods of bitter cold; temperatures of ≤32 °F occur less than 25 days per year. Temperatures below 0 °F rarely occur. The average mean temperature is 57 °F. The average annual precipitation is 37 inches and is well distributed through the year.

5. FINDINGS.

a. Sources of Information. This investigation is based on observations made during the site visit, interviews with plant employees, and a review of available site documents. A list of personnel contacted is included in Appendix B. A list of the documents consulted is provided in Appendix A. Approximately 3 inches of snow covered the ground during the site visit. This did not seriously impair the ability to assess the area because most of the property is paved and all the key areas of concern were located inside one or more of the structures.

b. Site History.

(1) The original St. Louis Ordnance Facility was constructed in 1941-42 on 276 acres. The original ordnance plant was the largest small-arms ammunition plant in the world. The present SLAAP consists of a 21-acre remnant that occupied the northern extremity of the original parcel. The present SLAAP area was used for small arms manufacture until 1944. In 1944, this area was converted to 105-millimeter (mm) projectile production.

(2) After World War II, SLAAP was placed in standby status. The SLAAP was reactivated twice to support military operations, from 1951-54, and 1966-69; in both instances to continue production of 105 mm projectiles. When operations were finally terminated in December 1969, a total of 23,878,646 projectiles had been produced.

(3) In 1984, several buildings at SLAAP were renovated to provide additional Department of Defense office space within the St. Louis area. Occupancy began in February 1985. At that time, Bldgs 5, 6, and a portion of Bldg 3 were occupied by over 500 people.

(4) In 1989, the Army determined that SLAAP was no longer required to support its ammunition mission. All industrial equipment was removed. On 1 October 1990, complete ownership and operational control was transferred to the U.S. Army Aviation Systems, now ATCOM, from the U.S. Army Armament, Munitions and Chemical Command (AMCCOM). Maintenance and surveillance of SLAAP has been conducted by Plant Facilities and Engineering, Inc., (PFE) since 1972. PFE is a subcontractor to Donovan Construction Company of Minneapolis, Minnesota.

c. Major Site Features. A detailed description of the major site features at SLAAP and any potential sources of hazardous substance storage, release, or disposal are presented below.

(1) Bldg 1, The Billet Cutting Building or "Nick and Break" Building.

(a) Bldg 1 consists of single story steel framework and roof truss building with corrugated asbestos siding. The building size is 141'10" x 61'0" (reference 4). The floor is reinforced concrete. Long steel billets or bars were cut into prescribed lengths using a nick and break method. Hydraulic systems were employed in the break operation. The steel billets were stored in concrete and H-beam racks east and west of the ends of the building. Spray and quench operations were also performed in this building. All solid wastes and some liquid wastes were removed by a local contractor (reference 1). Wash-down type liquid wastes were pumped directly into the sewage system.

(b) Bldg 1 was empty except for some miscellaneous equipment storage. All machinery has been removed. The billet storage racks have been removed and are now parking lots. The only potential source of contamination remaining at Bldg 1 is the corrugated asbestos siding. The only potential hazardous substance identified at Bldg 1 was the corrugated asbestos siding. The asbestos siding was reported to be not friable (reference 6).

(2) Bldg 2, The Forge Building.

(a) Bldg 2 is located in the northern corner of SLAAP. Bldg 2 consists of steel framework and roof trusses with corrugated asbestos siding and roof. The building size is 302'3" X 241'10-3/4" (reference 4). The floor is reinforced concrete. Bldg 2 contained 10 rotary gas- and oil-fired furnaces,

[redacted] The cut steel billets from the "Nick and Break" building were forged into a cylindrical shape in Bldg 2. [redacted]

(b) Bldg 2 was empty except for some miscellaneous storage. The rotary forges have been removed. Several hundred filing cabinets, metal shelving, and a few forklifts were stored in the building at the time of the site visit. [redacted] The asbestos siding was reported to be not friable (reference 6).

(3) Bldg 3, The Machining Building.

(a) Bldg 3 is the largest structure at SLAAP. This building consists of a two-story steel frame and roof beams on reinforced concrete walls and piers with spread footings. Portions of the walls also consist of solid brick masonry, and in portions of the north, south, and east sides, corrugated asbestos. The floors are reinforced concrete with three types of surfaces; asphaltic tile, wood block, and cement. A basement underlies the building. The building size is 830' 3-1/4" x 200' 11" (reference 4).

(b) Bldg 3 was initially used for small arms manufacturing from 1941 until 1944. In 1944 it was converted to the machining of 105 mm projectiles. [redacted] contained various lathe operations; hydraulic presses; conveyors; air driven machinery for cutting, shaping, and finishing of metal; quenching and metal treating processes; and stripping and metal preservative operations. Cutting oil used in the machining process contained polychlorinated biphenyls (PCBs). Steam lines were insulated with asbestos.

(4) PCB Contamination - Bldg 3. The PCBs were discovered in a portion of Bldg 3 by the General Services Administration (GSA) on 3 April 1990.

(a) The PCBs were initially discovered in the flooring. The flooring consisted of reinforced concrete with a layer of wooden blocks cemented to the concrete by a mastic or tar-like material. The area tested had been designated for temporary Veterans Administration (VA) file storage. The wood blocks were removed and the underlying floor was scarified. This portion of the building, however, has never been certified as clean.

(b) More widespread sampling and testing was conducted by Missouri Department of Natural Resources (DNR) on 3 January 1991. Results from that testing showed that the walls and floors of both building stories were contaminated. On the basis of those results, the Federal Environmental Protection Agency (EPA) issued a Notice of Violation (NOV) dated 20 February 1991 (reference 8). The NOV required evidence of the removal and proper disposal of all contaminated mastic and wood from both floors, removal and proper disposal of all contaminated plastic and fiberboard from the file storage area, decontamination of all non-porous surfaces to less than 10 micrograms/100 cm^2, and decontamination of all porous surfaces to less than 10 parts per million. The NOV also specified that the cleanup be complete before building occupancy takes place.

(c) The installation initiated a contract to remove the wood block, clean the floors, and clean the walls to a height of 8.5 feet. The contract for $1.6 million was awarded in September 1991. This cleanup was ongoing while the site visit occurred. An additional $200,000 worth of modifications to the initial contracts had been awarded. More modifications were expected.

(d) The ongoing cleanup contract does not comply with the terms of the NOV. The EPA confirmed this in a letter dated 9 April 1992 (reference 12). That letter stated "Please be aware that all areas of the building which may have been contaminated with PCBs, including those areas above 8 eight feet, 6 inches, must be sampled. If pre-cleanup sampling indicates contamination greater than 10$\mu g/100cm^2$, decontamination will be required." Not only did the contract not include all the inner building surfaces, but some sample results from areas that have been cleaned had not met the required EPA standards.

(e) Compliance with the terms of the NOV will be difficult. The ceiling height is about 15 feet. The ceiling area includes a maze of girders, electrical conduits, light fixtures, fans, and duct work, all with individual surfaces.

(3) Bldg 3 Basement Area. The Bldg 3 basement area contained a number of potential contamination areas.

(a) Pipelines. Pipelines were insulated with asbestos. The insulation was in poor condition. This is discussed in more detail in paragraph 5c(18).

[redacted] A transformer vault was located in the basement along the northern side of Bldg 3. The vault consisted of a small room with a concrete floor approximately 2 ' x 50' in size. The transformers were no longer present. The transformers most likely contained PCBs and any transformer oil spillage may have left some residual PCB contamination.

[redacted] Metal cuttings from the machining process were collected, centrifuged, and deposited via a bucket elevator to a railroad car outside the building. The bucket elevator assembly was generally referred to as the "chip chute." Exact details of the structure are no longer available. A review of plans and photographs suggests that hoppers were located on the first and second floors. These hoppers conveyed the chips via some form of conveyor system to railroad cars outside the building. The external structure apparently extended over two sets of railroad tracks along the north side of Bldg 3. The "chip chute" was located along the northern wall of Bldg 3 near the center of the building. All that remains of the "chip chute" structure is an empty internal shaft inside Bldg 3. A picture in the Survey and Inventory from 1945 (reference 4) shows a stained and wet area entitled "Condition of Basement, Building No. #3 - North Side - Due to Waste Water From Chip Conveyor." This picture and caption are another indication of the possibility of soil contamination in the basement around the base of the shaft.

[redacted] The pervasive use of cutting oils in the overhead structure suggests the possibility that oil may have also contaminated portions of the basement. Oil seepage could have occurred through expansion joints in the floor, around the transformer pads, and in the vicinity of the "chip chute" shaft. Possible random dumping may have also occurred.

(6) [redacted] Bldg 3 has corrugated asbestos siding. The asbestos siding was reported to be not friable (reference 6). Bldg 3 has known PCB contamination spread throughout the inner surfaces of the building. The EPA has issued an NOV to clean these surfaces. The SLAAP has not completely complied with that NOV. Pipelines in the basement were insulated with deteriorating asbestos. Potential sources of contamination included possible PCB contamination in the transformer vault area, metals and oil contamination in the "chip chute" area, and possible PCB and oil contamination throughout the basement area.

(7) Bldg 3, Options. Bldg 3 occupies the central portion of the parcel. The disposition of Bldg 3 will affect the disposition of the entire parcel. The proposed decontamination of Bldg 3 for unrestricted future use should be reassessed. Several options should be considered.

(a) The first option would be to continue to prepare Bldg 3 for [illegible] unrestricted use. This option would require compliance with the present EPA NOV and decontamination of all of the surfaces inside the Bldg 3 area. Any portions of the basement area that are most likely to contain PCB contamination would also need to be identified and sampled. Depending on the levels of PCBs detected, any PCB contaminated areas in the basement may also need to be cleaned up. The other environmental areas of concern i.e., asbestos pipeline insulation, suspected lead based paint, and possible lead in the water would also need to be mitigated.

(b) The second option would be to raze Bldg 3 and properly dispose of the debris. The friable asbestos material would also have to be properly disposed of. This option may allow the installation to avoid prolonged and expensive cleanup of the interior surfaces of Bldg 3.

(c) The third option would be to limit future use and restrict access to Bldg 3. With restricted access, the EPA might consider less stringent cleanup standards. Under the provisions of 40 Part 761.120(a)(1) (reference 13), the EPA has discretionary authority to determine cleanup standards for PCB spills that occurred prior to 1987. The EPA could be requested to consider the difficulty, expense and practicality of attaining decontamination of the interior surfaces of Bldg 3. The EPA could be requested to reconsider the necessity of the Bldg 3 cleanup on the basis of restricted access and future use restrictions.

(d) The installation should conduct a cost analysis to determine the most favorable option. The installation should immediately notify the EPA about the potential for additional PCB spillage in the basement area and coordinate with the EPA the installation's reassessment of Bldg 3 disposition. The USAEHA is available to assist the installation in assessing the disposition of Bldg 3, in any coordination, meetings or negotiations with the EPA, and in certifying decontaminated areas as clean.

[redacted]

(a) Bldg 4 is located near the eastern corner of SLAAP. This building consists of steel framework on reinforced concrete walls and piers with spread footings, and some corrugated asbestos siding and roofing. The floors are reinforced concrete. The building size is 163'8" x 51'10" (reference 4).

(b) Bldg 4 housed a series of air compressors. The air compressors have been removed and the building is now empty. The only potential hazardous substance identified at Bldg 4 was the corrugated asbestos siding. The asbestos siding was reported to be not friable (reference 6).

[redacted] Bldg 5, Headquarters and Office Building.

(a) Bldg 5 is located near the southern corner of SLAAP. This building is two stories, consisting of steel framework on reinforced concrete walls and piers with spread footings. The floors are reinforced concrete. Some corrugated asbestos siding was used in the walls. A basement underlies the building. The building size is 237'2" x 41'10" (reference 4).

(b) Bldg 5 was used as a loading plant for small arms from 1941 until 1944. Small arms ammunition loading machinery was then removed and the building was converted into an administrative office building. The building has been recently renovated. Carpet was placed over the asbestos tile floor covering, and paneling was placed over glazed brick walls. The basement area still contains pipelines insulated with asbestos. The asbestos is in deteriorating condition.

(c) Bldg 5 has some corrugated asbestos siding. The asbestos siding was reported to be not friable (reference 6). Bldg 5 contains deteriorating asbestos insulation of the pipelines.

[redacted] Bldg 6, Former Metallurgical Laboratory.

(a) Bldg 6 is located along the southern boundary of SLAAP. This building is two stories, consisting of steel framework on reinforced concrete walls and piers with spread footings. Some corrugated asbestos siding was used in the walls. The floors are reinforced concrete. A basement underlies the building. The building size is 237'6" x 41' 10" (reference 4).

(b) Bldg 6 was used as a small arms primer insert building from 1941 until 1944. Small arms primer inserting machinery was removed and the building was converted into office

space. [redacted] The laboratory performed quality control. Operations included polishing, measuring, and some etching. [redacted] Liquid waste was flushed into the [redacted] and sanitary sewage system. [redacted] area still contains pipelines insulated with [redacted] asbestos is in deteriorating condition.

(c) Bldg 6 has some corrugated asbestos siding. The asbestos siding was reported to be not friable (reference 6). Bldg 6 contains deteriorating asbestos insulation of the pipelines.

(11) Bldg 9 Area - Acetylene Generation and Sludge Pits.

(a) The Bldg 9 area is located east of Bldg 3 near the southern-most corner of SLAAP. The Bldg 9 area consisted of two small one-story buildings and two concrete sludge pits. This area was used for the production of acetylene gas. The gas production occurred in Bldg 9, which was 32'8 1/2 " x 33'6" in size (reference 4). Carbide was stored in Bldg 9A, which was 42' x 48' in size (reference 4). The acetylene was produced by adding water to the carbide. Sludge from the process, essentially a calcium oxide, was stored in two reinforced concrete pits between the two buildings. The pits were approximately 9 feet deep and 12'0" x 13'4" in size.

(b) All structures were removed and converted into a parking lot in 1978. No hazardous substances have been identified at this site.

(12) Underground Storage Tanks (USTs).

(a) At the time of the site visit, SLAAP contained five USTs and a sludge pit. The sludge pit was being considered as an UST. Four of the USTs and the sludge pit were located along the east end of Bldg 3. One UST was located along the west side of Bldg 2. The five tanks were constructed of steel. The sludge pit was constructed of concrete. All but Tank 105 are believed to have been installed in 1945. Tank 105 was installed in 1967 apparently to replace the original tank installed in 1945. The tanks were last used in 1969. Three of the USTs east of Bldg 3 were used to store quench oil, which was a non-PCB #6 Bunker oil. The sludge pit was used to collect the quench oil and settle any sludge before reuse. Two of the tanks, (Tank 101 west of Bldg 2, and Tank 105 east of Bldg 3) were used to store gasoline.

(b) A detailed study of the USTs using a series of soils borings and soils samples was completed in February 1992 (reference 2). A summary description of the tanks and tank contents is presented in Table 1. A summary of borings and soil sample results is presented in Table 2. Soil contamination was detected in the soils surrounding the tanks. The USTs and sludge pit were being removed as this report was being prepared. Any contamination discovered during tank removal was to be remediated in accordance with requirements of the State of Missouri. The installation anticipated receiving an approved closure report for the USTs from the State of Missouri after the tank and contaminated soil removal had been completed. Once approved closure of the UST sites has been attained, no hazardous substances should remain.

(13) The Tank Farm Area, Bldg 8. The Tank Farm Area was located along the eastern side of Bldg 2. This site consisted of nine aboveground tanks, ranging in size from 16,000 gallons to 19,000 gallons. The tanks were enclosed by earthen berms on the north, east, and west, and a slope on the south. The dimensions of the bermed area was 196 x 130'. The tanks were used to store fuel for the furnaces in Bldg 2. The exact type of fuel was not identified. The nine tanks were dismantled and removed in 1986. The tanks were given to the State of Missouri, relocated, and used to store asphalt. The former tank farm area has been regraded and paved over. No hazardous substances were identified at this site.

(14) Pesticides. Pest control at SLAAP has been maintained by an off-post contractor. Pesticide usage has consisted of pigeon control, rodent control, and insect control. There has been no reported storage of pesticides, herbicides, or insecticides at SLAAP (references 1 and 5), or any indication that pesticide storage ever occurred.

(15) Lead Paint. Lead-based paint is suspected to have been used on both the interiors and exteriors of buildings at SLAAP. Interior surfaces were frequently observed to have chipped or flaking paint. If the property is excessed for unrestricted use, regulations concerning lead-based paint in residential structures may apply. Those regulations are detailed in 24 CFR 35 (reference 9). The regulations require that "purchasers and tenants of HUD-associated housing constructed prior to 1978 shall be notified:

(a) That the property was constructed prior to 1978;

(b) That the property may contain lead-based paint;

~~Barbara~~ Dori-
Mann
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TABLE 1

[redacted] - UST INVESTIGATION

TANK CONTENTS ANALYSIS AND OBSERVATIONS

TANK	CONTENTS		LIQUID			SLUDGE		
	DESCRIPTION	QTY,gal	DESCRIPTION	QTY,gal	PCB,ppm	DESCRIPTION	QTY,ppm	METALS,ppm
Quench # 87	100 % Full water w/oil & sludge	14,100	ca. 99% Water ca. 1% Oil	ca. 13,959 ca. 141	BDL	Murky, Floating, no solids	< 0.14	NSS
Quench # 17	100 % Full water, no oil & sludge	15,220	ca. 99.9% Water ca. <0.1% Oil	ca. 15,205 ca. 15	BDL	Murky, Floating, no solids	< 0.07	NSS
Quench # 15	100 % Full water w/oil on top & sludge	15,335	ca. 98% Water ca. 2% Oil	ca. 15,028 ca. 307	BDL	Murky, Floating, no solids	< 0.25	NSS
Sludge Pit	18.5 % Full water w/oil on top & sludge in the sludge chamber.Water & no oil or sludge on overflow side	17,000	ca. 95% Water ca. 5% Oil	ca. 3,077 ca. 68	BDL	Murky, Floating, no solids	< 0.64	NSS
Gasoline # 105	100 % Full water w/oil on top & sludge	6,000	> 99.9% Water	ca. 6,000	BDL	clear, no solids	< 0.01	NSS
Gasoline # 101	Empty (Filled with sand on 4-1-59)	11,549	> 99.9% Water	ca. 200	BDL	>75% full of black, coal-like fines	< 40 yd^3	BTL

Legend:

ca. - Approximately
BDL - Below Detection Limits
BTL - Below Toxic Levels
NA - Not Applicable
NSS - Not Sufficient Sample for analysis

TABLE 2

SLAAP - UST INVESTIGATION

SOIL SAMPLE ANALYSIS AND OBSERVATIONS

----TANK----	---BOREHOLE---		----------DESCRIPTION----------			VOA (LAB 8240), ppm	TPH (LAB 418.1), ppm	TPH (FIELD), ppm	TOX METALS, (TCLP), ppm	BTEX, (LAB 8020), ppm
	No.	Depth	TEXTURE	COLOR	ODOR					
Quench Tanks & Sludge Pit	B-1	20'	silty clay	gray-black	[redacted]	BDL	11	< 3.5	BDL	NA
	B-2	13'	silty clay	gray-black	[redacted]	BDL	[redacted]70	< 1.0	BDL	NA
	B-3	17' (Water developed to 4')	silty clay	gray-black	[redacted]	BDL	[redacted]30	< 1.0	BDL	NA
	B-4	13'	silty clay	gray-black	[redacted]	BDL	[redacted]2	< 1.0	BDL	NA
	B-5	13' (Water developed to 4')	clay	gray	none	BDL	[redacted]8	< 2.0	BDL	NA
	B-6	20'	clay	gray	none	BDL	17	< 2.0	BDL	NA
	B-7	13'	clay	gray-green	none	BDL	40	< 1.0	BDL	NA
	B-8	13'	clay w/organic	gray-green	[redacted]	BDL	[redacted]09	< 3.0	BDL	NA
Gasoline Tank # 105	B-9	7'	sandy clay	gray-green	[redacted]	NA	[redacted]91	< 5.0	BDL	BDL
	B-10	13'	sand	gray	[redacted]	NA	72	< 500	BDL	BDL
Gasoline Tank # 101	B-11	20'	stiff clay	brown	none	NA	13	< 1.0	BDL	BDL
	B-12	20'	stiff clay	brown	none	NA	15	< 1.0	BDL	BDL

Legend:

BDL - Below Detection Limits
BTEX - Benzene/Toluene/Ethylbenzene/Xylene
NA - Not Applicable
TCLP - Toxicity Characteristic Leaching Procedure
TOX - Toxic
TPH - Total Petroleum Hydrocarbons
VOA - Volatile Organics Scan

(c) Of the hazards of lead-based paint;

(d) Of the symptoms and treatment of lead-based paint poisoning; and

(e) Of the precautions to be taken to avoid lead-based poisoning (including maintenance and removal techniques for eliminating such hazards)." Any future prospective property users should be notified about the lead-based paint.

(16) Lead in Potable Water. Potable water is purchased from the St. Louis water system. Distribution points at SLAAP have never been sampled for lead. Water supply lines at SLAAP were installed at a time when lead solder was commonly used. There is a potential for lead levels in drinking water at SLAAP to exceed the National Primary Drinking Water Regulations (NPDWR) action level of 0.015 mg/L. Water distribution points should be sampled to determine the presence of lead. Guidance for sampling procedures can be obtained from the EPA's Lead and Copper Rule Guidance Manual (reference 10).

(17) Wastewater, Landfills and On-site Refuse Disposal. Industrial and sanitary wastewater at SLAAP was discharged into the St. Louis municipal sewer system. All trash, waste, and refuse was collected and hauled away by a contractor. There are no waste burial sites identified at SLAAP (reference 1).

(18) Asbestos. An asbestos survey of SLAAP was conducted in June and July 1991 (reference 6). The results of that survey are summarized below:

(a) Corrugated asbestos (transite) siding was used in Bldgs 1, 2, 3, 4, 5, and 6, bldg crossovers, and the western guard shack. This material was reported to be not friable. Extensive measures or actions were not recommended for this material.

(b) Stock items consisting of packing and gasket material were reported in Building 4. These items were recommended to be bagged and properly disposed of.

(c) Thermal system insulation (TSI) was found on abandoned pipelines in Bldg 4A (annex), Bldg 7, and the basement of Bldgs 3, 5, and 6. This material was found to be in poor condition and considered friable. Repairs were recommended.

(d) The floor tile and mastic in Bldgs 3, 5, and 6 were found to contain non-friable asbestos. Extensive measures and actions were not recommended.

(e) The adhesive for paneling in Bldg 6 was found to contain non-friable asbestos. Extensive measures and actions were not recommended.

(f) Friable, asbestos-containing building material was reported on a 1" hot water line in a pipe chase of Bldg 5-2. This pipe chase was recommended for isolation or removal. All pipe chases in Bldgs 3, 5, and 6 were reported as suspect and needing inspection.

(19) Radon. A radon survey was completed in the basements of Bldgs 3, 5, and 6 from December 1991 through June 1991 (reference 7). AR 200-1 (reference 11) requires that mitigation be taken if the annual average radon concentration in a structure exceeds 4 picoCuries per liter (pCi/L) of air. Five years is allowed to accomplish this mitigation. Bldgs 3 and 6 did not exceed this concentration. The basement area of Bldg 5 had an overall concentration average of 5.29 pCi/L of air. Access to all basement areas was restricted and increased monitoring was placed in Bldg 5. If increased monitoring shows that the radon annual average is greater than 4 pCi/L then mitigation measures will be required in Bldg 5.

d. Possible Sources of Adjacent Contamination. Residential areas adjoin SLAAP to the northwest and southeast. Interstate 70 lies along SLAAP's northeastern boundary. A residential area is situated directly across Interstate 70 from SLAAP. The area along SLAAP's southwestern border was formerly part of the original St. Louis Ordnance Facility. This area is now a light industrial area consisting mainly of warehouses. Based on observations of present adjoining property usage, no sources of adjacent off site contamination could be identified that might adversely impact SLAAP.

6. SUMMARY. A summary of the major site features at SLAAP and any associated hazardous substance or potential hazardous substance is presented in Table 3.

7. CONCLUSIONS. Releases of hazardous substances have been confirmed within some of the structures at SLAAP. Releases of other hazardous substances are also suspected. The key areas of known or suspected hazardous substance release are presented below.

a. Major amounts of PCBs have been released into the internal structure of Bldg 3.

TABLE 3. SUMMARY OF MAJOR SITE FEATURES AT SLAAP AND KNOWN OR POTENTIAL HAZARDOUS SUBSTANCES

E	KNOWN OR POTENTIAL HAZARDOUS SUBSTANCE
Bldg 1 Nick and Break Building	Non-friable corrugated asbestos
Bldg 2 The Forge Building	Non-friable corrugated asbestos
Bldg 3 The Machining Building	Non-friable corrugated asbestos Non-friable asbestos in the floor tile and mastic PCB contamination of inner surfaces and pending EPA NOV for cleanup
Bldg 3 Basement	Deteriorating asbestos insulation of pipelines Transformer vault area - possible PCB contamination Chip Chute shaft area - possible metals and PCB contamination Possible random PCB contamination in earthen basement floor
Bldg 4 The Compressor Building	Non-friable corrugated asbestos
Bldg 5	Non-friable corrugated asbestos Non-friable asbestos in the floor tile and mastic Headquarters and Office Deteriorating asbestos insulation of pipelines Minor radon contamination in basement
Bldg 6 Former Metallurgical Laboratory	Non-friable corrugated asbestos Non-friable asbestos in the floor tile and mastic Deteriorating asbestos insulation of pipelines

TABLE 3. SUMMARY OF MAJOR SITE FEATURES AT SLAAP AND KNOWN OR POTENTIAL HAZARDOUS SUBSTANCES (continued)

S	KNOWN OR POTENTIAL HAZARDOUS SUBSTANCE
Bldg 9 Area Former Acetylene Generation Area	None, site vacated
Underground Storage Tanks	Closure in progress, State approval imminent pending satisfactory completion
Bldg 8, Former Tank Farm Area	None, site vacated Tank Farm Area
Pesticide Storage	None
Interiors and exteriors of building walls	Possible lead based paint
Water supply lines	Possible lead contamination
Landfills and On-site Refuse Disposal	None, no on-site disposal
Bldg 4 - Stock items	Friable asbestos
Pipeline insulation in Bldg 4A (annex), Bldg 7, Basement - Bldgs 3,5,6	Friable asbestos
Bldg 5-2 - Pipe chase Bldgs 3,5,6 - possible pipechases	Friable asbestos
Possible Sources of Adjacent Contamination	None

b. The EPA has issued an NOV requiring PCB cleanup of the internal surfaces of Bldg 3. The ongoing Bldg 3 cleanup does not fully comply with that NOV.

c. Deteriorating asbestos pipeline insulation exists in Bldg 4A, Bldg 7, and the basements of Bldgs 3, 5, and 6.

d. Lead-based paint is suspected to have been used on both the exteriors and interiors of the buildings.

. The water supply lines may contain enough lead to cause [illegible] to exceed the NPDWR action level in the drinking water.

f. Based primarily on consideration of heavy PCB usage in Bldg 3, the underlying earthen basement is also potentially contaminated with PCBs.

g. The basement area of Bldg 5 slightly exceeded recommended radon levels.

8. RECOMMENDATIONS.

a. Reassess the proposal of unrestricted future use for Bldg 3. Because Bldg 3 occupies a large and central portion of the installation property, the disposition of Bldg 3 could impact the proposed excess of the entire SLAAP parcel.

b. Conduct a cost analysis of Bldg 3 decontamination, Bldg 3 destruction and proper disposal, or Bldg 3 restricted access.

c. Immediately notify the EPA about the potential for additional PCB contamination in the basement area of Bldg 3.

d. Coordinate with the EPA the installation's reassessment of Bldg 3 disposition. The USAEHA is available to assist the installation in assessing the disposition of Bldg 3, in any coordination, meetings or negotiations with the EPA, and in certifying decontaminated areas as clean.

e. Notify the receiving part of all hazardous substance releases known to have occurred. Take the following actions if the SLAAP property is to be excessed for unrestricted use.

(1) Implement the appropriate repairs and corrective actions for all identified areas of deteriorating and friable asbestos.

(2) Sample water distribution points to determine the presence of lead.

(3) Notify any prospective recipient of the potential for the property to contain lead based paint.

(4) Continue to maintain increased radon monitoring in the basement of Bldg 5 to determine if further mitigation measures are necessary.

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APPROVED:

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Program Manager
Ground Water and Solid Waste

APPENDIX A

REFERENCES

1. Installation Assessment of St. Louis Army Ammunition Plant, Report No. 153, prepared for USATHAMA, December 1979.

2. Underground Storage Tank Investigation, St. Louis Army Ammunition Plant, JD Chelan, 3 February 1992.

3. Update of the Initial Installation Assessment of St. Louis Army Ammunition Plant, St. Louis, MO, prepared for USATHAMA, July 1987.

4. Survey and Inventory of Class A Property, Chevrolet Shell Division General Motors Corporation, (St. Louis Ordnance Plant), St. Louis, Missouri, prepared by the U.S. Army Corps of Engineers, St. Louis, Missouri, 26 June 1945.

5. Memorandum, AVSCOM, SAVAI-F, 16 July 1991, subject: Pest Management Plan, St Louis Army Ammunition Plant, 4800 Goodfellow Boulevard, St. Louis, Missouri.

6. Memorandum, Plant Facilities and Engineering, Inc., 11 July 1991, subject: Asbestos Survey Report.

7. Memorandum, Plant Facilities and Engineering, Inc., 21 August 1992, subject: Radon Survey Report.

8. Letter, U.S. Environmental Protection Agency, 20 February 1991, Notice of Noncompliance, TSCA Docket Number VII-91-T-304.

9. Title 24, Code of Federal Regulations (CFR), 1992 rev, Part 35, Lead-Based Paint Poisoning Prevention in Certain Residential Structures.

10. Lead and Copper Rule Guidance Manual, Volume I: Monitoring, for Drinking Water Technology Branch, Drinking Water Standards Division, Office of Ground Water and Drinking Water, U.S. Environmental Protection Agency, Washington, D.C., September 1991.

11. AR 200-1, 23 April 1990, Environmental Protection and Enhancement.

12. Letter, U.S. Environmental Protection Agency, 9 April 1992.

13. Title 40, CFR, 1992 rev, Part 761, Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions.

APPENDIX B

PERSONNEL CONTACTED
(In alphabetical order)

1. Mr. Jerry Doud, Facilities Contracting Office Representative, Engineering and Housing Division, Administrative and Installation Support Activity (AISA), ATCOM.

2. Ms. Veronique Hauschild, Environmental Scientist, Waste Disposal Engineering Division (WDED) USAEHA.

3. Mr. Jim Kuehnle, Environmental Engineer, Environmental Compliance Division, AISA, ATCOM.

4. Mr. Paul Kohlberg, Facilities Engineer, PF&E Inc.

5. Mr. Henry Moglia, Chief, Environmental Compliance Division, AISA, ATCOM.

6. Mr. John Patterson, PCB Cleanup Coordinator, Engineering and Housing Division, AISA, ATCOM.

7. Mr. John Resta, Program Manager, Hazardous and Medical Waste Management, WDED, USAEHA.

8. Mr. T. Michael White, Environmental Scientist, WDED, USAEHA.

APPENDIX C

GENERALIZED STRATIGRAPHIC COLUMN FOR ST. LOUIS, ST. CHARLES, AND JEFFERSON COUNTIES

Source: Reference 1

TABLE 1

GENERALIZED STRATIGRAPHIC COLUMN FOR ST. LOUIS, ST. CHARLES, AND JEFFERSON COUNTIES, MISSOURI

System	Series	Group	Formation	Aquifer Group	Thickness (Meters)	Dominant Lithology	Water-bearing Character
Quaternary	Holocene		Alluvium[1]/*		0-46	Sand, gravel, and clay.	Some wells yield more than 7,570 l/min.
	Pleistocene		Loess		0-34	Silt	Essentially not water yielding.
			Glacial till		0-17	Pebbly clay and silt.	
Pennsylvanian	Missourian	Pleasanton	Undifferentiated	1	0-23	Shales, siltstones, "dirty" sandstones, coal beds and thin limestone beds.	Generally yields very small quantities of water to wells. Yields range from 0 to 38 l/min.
		Marmaton	Undifferentiated		0-27		
	Desmoinesian	Cherokee	Undifferentiated		0-61		
	Atokan		Undifferentiated				
Mississippian	Meramecian		Ste. Genevieve Formation		0-49	Argillaceous to granular limestone.	Yields small to moderate quantities of water to wells. Yields range from 19 to 190 l/min. Higher yields are reported for this interval locally.
			St. Louis Limestone*		0-35		
			Salem Formation*		0-58		
			Warsaw Formation*		0-34		
	Osagian		Burlington-Keokuk Limestone		0-75	Cherty limestone.	
			Fern Glen Formation		0-32	Red limestone and shale.	
	Kinderhookian	Cadueau	Undifferentiated		0-37	Limestone, dolomitic limestone, shale, and siltstone.	
Devonian	Upper	Sulphur Springs	Bushberg Sandstone		0-18	Limestone and sandstone.	
			Glen Park Limestone				
			Grassy Creek Shale		0-15	Fissile, carbonaceous shale.	
Silurian			Undifferentiated		0-61	Cherty limestone.	
Ordovician			Maquoketa Shale		0-50	Silty, calcareous or dolomitic shale.	Probably constitutes a confining influence on water movement.
	Cincinnatian		Cape Limestone		0-2	Argillaceous limestone.	
	Champlainian		Kimmswick Formation*	2	0-44	Massive limestone.	Yields small to moderate quantities of water to wells. Yields range from 11 to 89 l/min. Decorah Formation probably acts as a confining bed locally.
			Decorah Formation		0-15	Shale with interbedded limestone.	
			Plattin Formation		0-73	Finely crystalline limestone.	
			Rock Levee Formation		0-28	Dolomite and limestone, some shale.	
			Joachim Dolomite*		0-41	Primarily argillaceous dolomite.	
			St. Peter Sandstone*	3	0-49	Silty sandstone, cherty limestone grading upward into quartzose sandstone.	Yields moderate quantities of water to wells. Yields range from 38 to 530 l/min.
			Everton Formation*		0-40		
	Canadian		Powell Dolomite*	4	0-46	Sandy and cherty dolomites and sandstone.	Yields small to large quantities of water to wells. Yields range from 38 to 1,136 l/min. Upper part of aquifer group yields only small amounts of water to wells.
			Cotter Dolomite		0-98		
			Jefferson City Dolomite		0-69		
			Roubidoux Formation*		0-54		
			Gasconade Dolomite* Gasconade Sandstone Member		0-85		
Cambrian	Upper	Elvins	Eminence Dolomite*	5	0-52	Cherty dolomite, siltstones, sandstone and shale.	Yields moderate to large quantities of water to wells. Yields range from 38 to 1,514 l/min.
			Potosi Dolomite*		0-99		
			Derby-Doerun Dolomite		0-60		
			Davis Formation		0-46		
			Bonneterre Formation		75-117		
			Lamotte Sandstone*		72+		
Precambrian						Igneous and metamorphic rocks.	Does not yield water to wells in this area.

1/ Basal part may be of Pleistocene Age.

NOTE: Stratigraphic nomenclature may not necessarily be that of the U.S. Geological Survey.

* Water-bearing formations.